SAFETY ENGINEERING
RESOURCES

Stevens v. Cuprum

Prepared for: Bruce McIntosh

SER Job Number: SER 30-007
L D Ryan PhD PE

Accident Reconstruction:

Clifford Stevens was in the process of cleaning his gutters when his extension ladder failed, sending him falling to the ground. The ladder was first set up on the deck near the great room wall. Mr. Stevens extended the ladder to approximately three feet above the roof of the great room. He cleaned the gutters on this roofline from the ladder. He then climbed from the ladder onto the roof, while his sons moved his ladder to rest on the gutter of the bedroom roofline section. Stevens mounted the ladder, and stepped down so his chest was about even with the gutter when the ladder suddenly telescoped downward, then stopped suddenly, sending Mr. Stevens falling to the deck below.

What Happened?

Safety Engineering Resources took the given information, the victim's deposition, the ladder geometry, the damage to the subject ladder, the configuration of the two rooflines, and other data to reconstruct the accident. When Mr. Stevens raised the ladder before placing it against the first roof-line, he did not visually confirm that the ladder's fly locks were locked in place, he just moved the ladder until he felt what he thought were the locks engaging the ladder rung correctly. The ladder may or may not have been properly locked in the extended position at this time. There is a reasonable degree of engineering certainty that the fly-locks were engaged because the fly-locks remained latched during the climb and there is the possibility of noticing that the ladder steps in the fly-section and the base-section are not aligned. Stevens states that there was about three feet of ladder extending above the roofline at the great room roof. The following drawing shows a likely configuration for the great room ladder set-up. The ladder height used in the drawing was determined using the witness marks on the accident ladder.

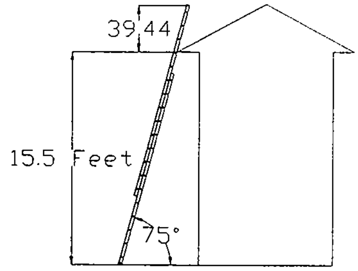


Figure 1: Ladder configuration at great room roofline

For the accident to have occurred, the fly-locks had to become false locked. It is most probable that the false lock occurred when Stevens' sons moved the ladder from the great room roofline to the bedroom roofline. Stevens' thinks that he told his sons to adjust the angle of the ladder in order for more ladder to extend above the roofline, and that they did not adjust the height of the ladder. Stevens also states that the top of the ladder was chest high before he began descending the ladder. The following drawing shows a possible configuration for the ladder set-up over the bedroom roof. This configuration uses the same ladder height as used on the great room.

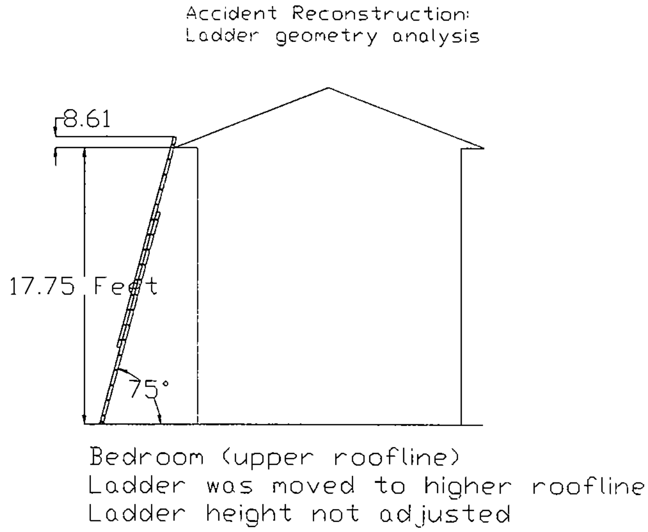


Figure 2: Configuration of Ladder on upper roofline, not extended

The ladder in Figure 2 was drawn set up at 75 degrees. Although 75 degrees is the optimal angle for ladder use, we have performed research showing most ladder users set ladders up at a more shallow angle, usually about 70 degrees. The following drawing shows this configuration.

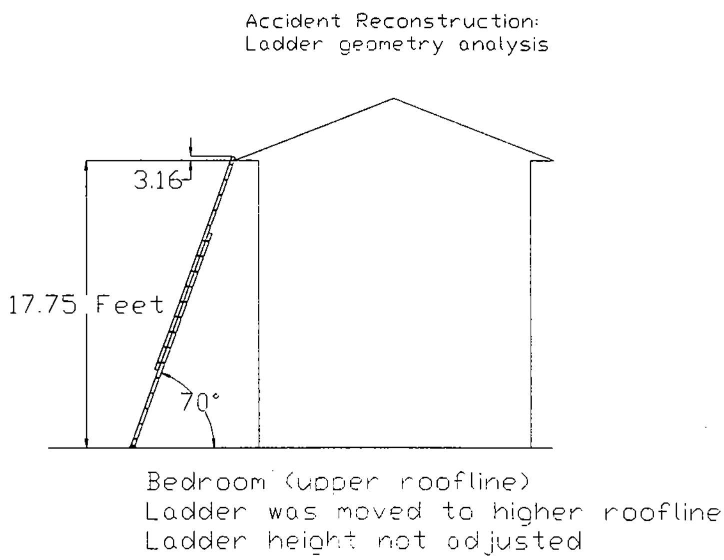


Figure 2b: Configuration of Ladder on upper roofline, not extended. 70 degrees

If Stevens' sons adjusted only the angle of the ladder to increase the clearance above the roof, it would have looked something like the following drawing. Note that the angle of the ladder is dangerously steep, 84 degrees compared to the manufacturer suggested 75 degrees. This severe change of the ladder angle did not put very much of the ladder above the roofline, only about 15 inches.

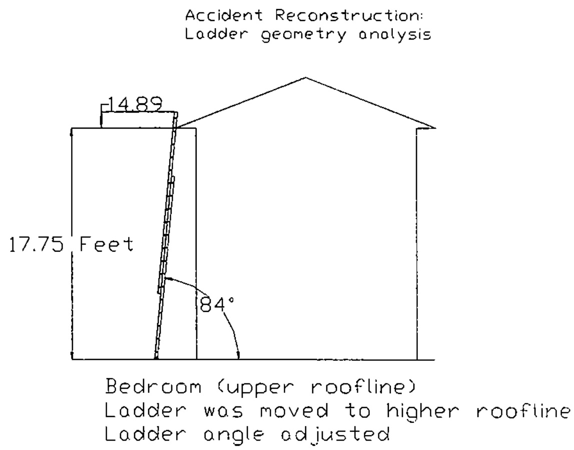


Figure 3: Configuration of Ladder on upper roofline, angle changed

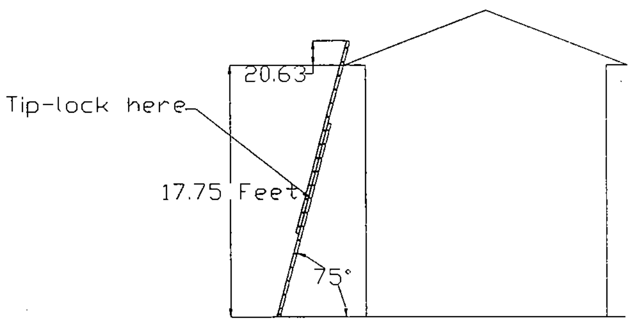
When Stevens' sons moved the ladder and adjusted the angle, they must have extended the ladder. Dimensionally, the ladder does not fit the higher roof from a practical viewpoint without extending the ladder. Recent communication with Stevens' sons confirms this fact. The following table shows the roofline clearance based on testimony of Mr. Stevens that the first set-up was about 3 feet above the roofline.

Angle	*Distance Above the Roof*
84°	14.89 inches
75°	8.16 inches
70°	3.16 inches

Extending the ladder probably created a false-lock. Stevens was on the roof, where it would have been difficult if not impossible to determine whether or not the fly lock mechanism was properly engaged or not. The photograph below from another of the author's false-lock cases shows the difficulty in seeing the fly-locks from above looking downward.

Had the ladder been designed so as not to false-lock, the ladder would have simply telescoped from the top to bottom before Mr. Stevens could get onto the ladder, if the fly locks had not been properly engaged. The following drawing shows the geometry of this scenario.

Accident Reconstruction:
Ladder geometry analysis



Bedroom (upper roofline)
Ladder was moved to higher roofline
Probable ladder height adjustment to increase clearance
puts fly lock tip-locked on 9th rung

Figure 4: Configuration of ladder on upper roofline, ladder extended

When Stevens changed his body position while descending the ladder to reach for the garden hose, he probably dislodged the false lock, sending the ladder telescoping downward. This theory is consistent with the witness marks on the ladder. There are marks on the ladder, which indicate that the right fly-lock was false-locked in a tip-locked position on the 9th rung of the base section. The left fly-lock was locked, but due to the tip lock, it was approximately 1 inch above the rung. The tip-lock on the right became dislodged and the left fly-lock impacted the 9th ladder rung leaving witness marks. The left fly-lock was defective and broke. This caused the ladder to telescope downward. The right flylock had time to move into position due to the attached rope and or ladder friction. The right fly-lock clearly impacts the 7th rung. The ladder is below the eaves so that it strikes the screen as it falls toward the house. In the process, Mr. Stevens falls. The following is a drawing showing this geometric configuration.

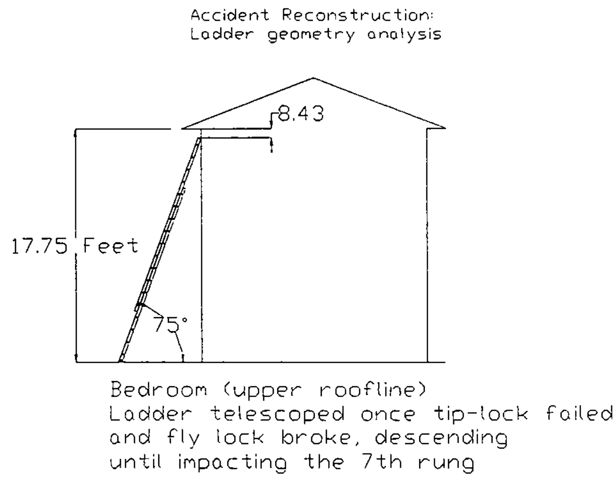


Figure 5: Ladder in final position after clearing roof, impacting the 7th rung and the window screen

The screen on the upper bedroom window apparently was damaged in the ladder accident. The screen has a ladder rail-sized hole in it. The report from Mr. Sunderlin puts the tear in the screen at 191 inches from the deck. From the photographs taken by Mr. Sunderlin and the known information about the house geometry, the tear location can be extrapolated, confirming the locating of the screen tear. Working backwards from the location of the tear, we can zero in on the accident scenario.

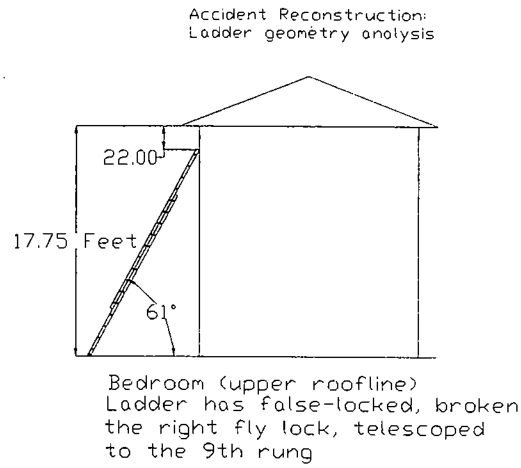


Figure 6: Ladder impacting bedroom window screen

The location of the tear in the screen was used in an Autocad drawing to position the ladder. This was done by using the determined extended length of the ladder, then rotating the ladder graphically from the screen position to an angle where it would have extended onto the roof, before the tip lock failed, sending the ladder crashing downwards. The ladder was then extended to the length at which it was set up at the bedroom roofline. This resulted in a set-up angle of 68 degrees. This is a very likely scenario, since the average user sets ladders up at 70 degrees. This is more evidence that supports the accident recreation. The following is an Autocad drawing showing the ladder location as evidenced by the window screen tear.

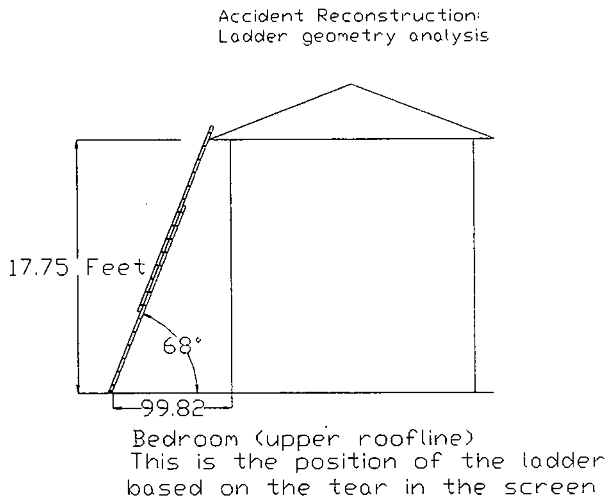


Figure 7: Ladder set-up prior to accident

Defendant's Knowledge of False Locking

The following Table 2 is a list of accident cases that the author or his staff was involved when at Ryan Engineering. (The author founded Ryan Engineering, sold the company and started Safety Engineering Resources.) The dates are missing, but the numbering system relates the job to the year that it came into Ryan Engineering. Case 9532 would be the 32nd case received in 1995, which was a Cuprum false-lock accident. From the data of Ryan Engineering, Cuprum would have known about the problem sometime before 1995. The case number 33 came into the office in 1989.

There is reference from the ANSI committee members about false locking of extension ladders. One member of the ANSI committee has written the author stating that false locking of extension ladders is a problem. Defense experts have regularly given testimony in depositions about false locking, and in this case defendants have acknowledge the involvement of a ladder that was false locked. In Dr. Dennis McGarry's report from SEA, he states, "***.the primary cause of the accident was the improper engagement of the fly locks in violation of the safety instructions."*** The ladder industry

including Cuprum has been aware of the false locking problem for years and has failed to design out the hazard.

Table 2. List of False-Lock Cases Involving Ryan Engineering

Case #	Plaintiff Attorney(s)	Legal Case Name	Description	Outcome / Status
33	Laizure, Tony 918-745-6084	*Kenneth Clayton v. California Ladders et al.* (The full legal case name is not in our files) Also listed as *"Clayton vs. Barber Enterprises CLM# Y40CW515456456J"* on TASA form.	Keller Model 3528 Type II Commercial extension ladder, 28', **false lock** (cam lock)	Plaintiff won 1.2 Million
9449	Hazlewood, Lee 601-283-2132	United States District Court for the Northern District of Mississippi Greenville Division, *Effie Cain as the Conservator of the Estate of Eugene Cain, Plaintiff, vs. R. D. Werner Company, Inc. and Sherwin Williams, Defendants*, No. 4:94CV24-B-D	Werner Model D-1532-2 Type I Heavy duty Extension Ladder, **false lock** (tip lock)	Settled
9532	Weyland, Karl 517-790-0777	State of Michigan, In the Circuit Court for the County of Bay, *Gerald L. Jehnsen and Sharon*	Cuprum Model No. 534-24, Type I-A, **false lock** (type of false lock uncertain)	Settled

		Jehnsen, Plaintiffs, vs. Builder's Square, Inc., a Delaware corporation, Davidson Ladders, Inc., a Tennessee corporation, Cuprum S.A. DE CV, a Mexican and/or foreign corporation, jointly and severally, Defendants, Case No. 96-3148-NP-B		
9618	Floyd, Walter 314-863-4114	*Nick Viviano vs. Werner* (The full legal case name is not in our files)	Werner Model D-1124-2 Type III Extension Ladder, **false lock**, lower rungs came loose from rail	Settled
9644	Moos, Pat 1-800-841-9055	Circuit court of the Thirteenth Judicial circuit of Illinois, Bureau county, *Bernard Sexton, Plaintiff, vs. Vangard Contractors, Inc., Halm electrical Contractors, Inc., and Halm Brothers, Inc., Defendants* and *Vangard Contractors, Inc., Third-Party Plaintiff, vs Soedler's Contracting Company of Peeru, an Illinois Corporation, Third-Party*	Werner Model No. 7124-2 24" Yellow Fiberglass Extension Ladder, **false lock**, (tip lock), tip of flylock had made hole in rung	Closed case, outcome not ir file

		Defendant, Case No. 94-L-43		
9828	Licata, Arthur 617-523-9977	Charles Martino's Estate (he was killed) against Keller Ladder. There was no case name in our files.	Keller Model 5128 Type IA Orange Fiberglass Industrial Heavy duty extension ladder, 28', **false lock,** ladder was recalled because a brace could interfere with flylock.	Closed case, outcome not ir file
9846	Thetford, Mark 800-709-5050	*James Armstrong vs. Keller Ladder* (The full legal case name is not in our files)	Keller Model 3224 Type II Commercial extension ladder, 24', **false lock** (cam lock)	Closed case, outcome not ir file
9854	Warren, John 205-221-1044	Michael Howard Lee against Werner Ladder. There was no case name in our files.	Werner Model No. D1124-2 Type III Extension Ladder, "Saf-T-Master", **false lock**	Closed case, outcome not ir file
9909	Willia, Richard 712-277-0686	*Julie Orban vs. Werner Manufacturing* (The full legal case name is not in our files)	Werner Model D-1128-2 Type III Extension Ladder, **false lock**, bottom of fly section hit on rung	Settled
9978	Armstrong, Matt 314-241-4844	District Court of the United States for the Southern Judicial District of Illinois East St. Louis, *Don Stewart and Karen Stewart,*	Keller Model 3528 Type II Commercial extension ladder, 28', **false lock**	Closed case, outcome not ir file

		Plaintiffs, vs. Keller Ladders, Inc., f/k/a Keller Industries, Inc. and/or Keller Industries, Inc., d/b/a Keller Ladders and/or U.S. Industries Corp. and/or U.S. Industries, Inc., Defendants, Cause No. 96-1074-WDS		
A00002	Nussbaum, Alan 800-232-9467	Michael Ernheart against Keller Ladder, Construction Company. There was no case name in our files.	Keller Model No. 3520 Type II Commercial Aluminum Extension Ladder, **false lock** (cam lock) we only determined that the ladder was not made by Werner, attorney had another expert.	Closed case, outcome not ir file
A00087	Gowan, Tom 610-272-4222	Court of Common Pleas of Philadelphia County, First Judicial District of Pennsylvania, Civil Trial Division, *Ronald A. Reichard, Jr. vs. Werner Ladder Company*, Case No. 3994	Werner Model D-6140-2 Orange Fiberglass Extension Ladder, **false lock** (tip lock)	Settled
A01024	Hatzel, Michael 502-585-3311	United States District Court, Western district of Kentucky, Louisville Division, Donnie	Keller Model No. 3520 Type II Commercial Aluminum Extension	Closed case, outcome not ir file

		Stevens, Theresa Stevens, Plaintiffs vs. Keller Ladders, Inc., Defendant, Case No. 3:97-CV-313-H	Ladder, rear fly model, **false lock** (cam lock)	
A01081	Murphy, Scott 407-838-2000	In the circuit court in and for Orange County, Florida, *FRANK GAY and GABRIELLE GAY, his wife, Plaintiffs, vs. GRUPO IMSA S.A. de C.V., CUPRUM S.A. de C.V. DAVIDSON LADDERS, INC., a Tennessee Corporation, BUILDERS SQUARE, INC., a foreign Corporation, and STRONGWELL CORPORATION, a Virginia Corporation, Defendants*, CASE NO.: CI099-1104	Cuprum Model No. 534-24, Type I-A, **false lock** (tip lock)	Jury Verdict, $ amount unknown to Ryan Engineeri
A01103	Miller, Peter 501-374-6300	*Carl Barger vs. Louisville Ladder* (The full legal case name is not in our files)	Davidson Model No. 405-24 Type II Aluminum Extension Ladder, equipped with QuickLatch, **false lock**	Active Case, In Process
A02014	Burck, Mark 713-400-6000	234th Judicial District court of Harris County, Texas, *Larry Cosby vs.*	Louisville Model No. L2121-28 Aluminum Extension Ladder,	Active Case, In Process

		Clayton Dawlins, Live Oak Roofing, Case No. 2001-44483	**false lock**	

Engineering Analysis:

False-Lock Analysis:

There are two common false-lock occurrences with the typical flylock design. The two are:

1. Flipper-lock
2. Tip-lock

With certain ladders made by another large manufacturer, the end of the fly section hits on the rungs. This type of false-lock has been experienced in two cases at Ryan Engineering involving this ladder. Both injuries were devastating. One injury resulted in a paraplegic victim and the other a quadriplegic. This third type of false lock is termed end-lock. The subject ladder "tip-locked" and did not flipper lock or end lock.

Flipper-Lock:

Shown in Figure 6 is a picture of the flylock on an exemplar ladder that is false-locked on the flipper. The flipper-locks are more unstable than the tip-locks or end-locks. The flipper lock as shown in Figure 6 does happen frequently. The analysis of a flipper-lock comes from the free-body diagram shown in Figure 7. The red arrow in Figure 6 represents the reaction force trying to move the fly-section downward. The black arrow in Figure 6 represents the friction force trying to prevent the fly-section from moving downward. The value of the red arrow wants to be larger than the black arrow so the fly-section of the ladder moves downward.

(Note all of the following engineering analysis is trivial, and it is based on ancient physics theory presented in engineering textbooks for years. These are the tools of engineering that do not require peer review like this is something new. The summation of forces and moments from a free-body diagram of the flylock is standard engineering analysis. There is no need for testing. There is no need for error analysis. There is only need for a qualified professional engineering expert to check for mathematical errors or errors in statics.)

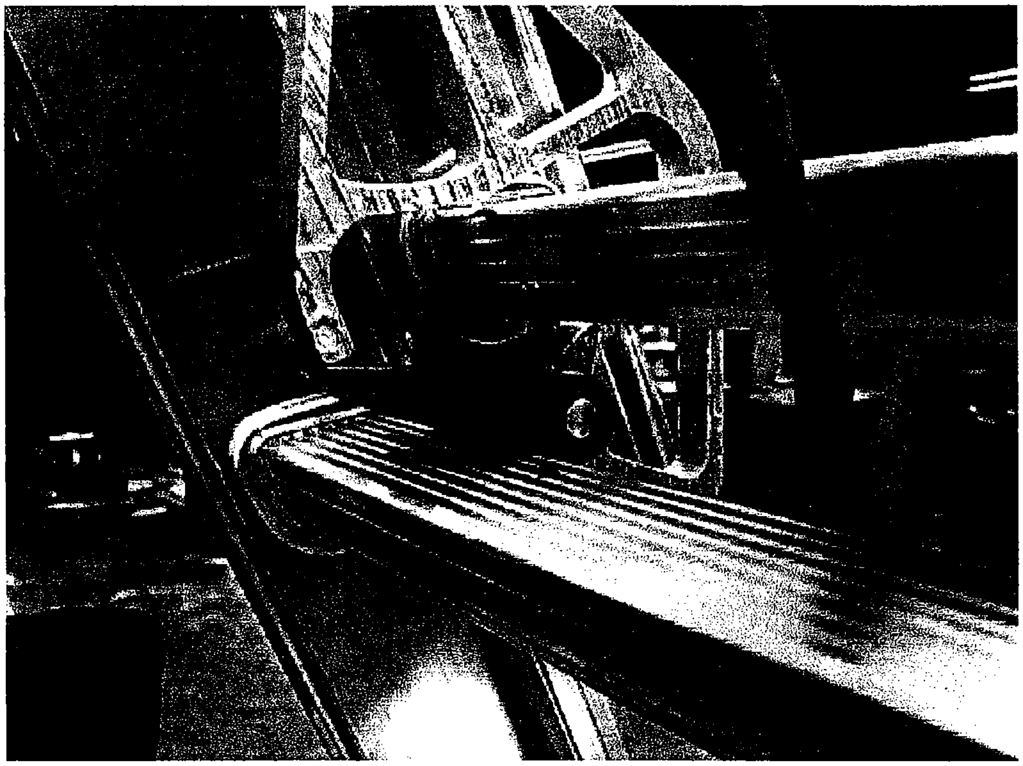


Figure 6. Flipper-Lock on Exemplar Ladder

In Figure 7 is shown a free body diagram of the typical ladder's flylock. The force F_2 equals the force transmitted from the pivot of the flylock to the tongue/rung contact point. N is the normal force at the rung/tongue contact point that is perpendicular to the tongue face. F_4 is the tangential component at the rung/tongue contact point that is parallel to the tongue face, and f is the frictional force resisting sliding of the tongue across the rung contact point.

If the fly section is not moving,

$$f = \mu_s \times N \quad \text{(Equation. 1)}$$

As shown in Figure 7, α is the angle between the slope of the tongue face at the contact point and a line connecting the contact point to the flylock pivot. The force N comes from the component of the F_2 perpendicular to the slope of the tongue face at the contact point. A smaller portion comes from the gravity force on the flylock and the torsion spring if the flylock is so equipped.

For this analysis the weight of the flylock and the torsion spring adding to N are neglected. F_2 is resolved into the components F_4 and N as is shown in Figure 7.

$$F_4 = f = \mu_s \times N \text{ (Equation. 2)}$$

The frictional force "f" is a maximum just before slip occurs. As an example, μ_s was measured as 0.308 for the typical Werner D1100 series extension ladder. As can be seen from Figure 7:

$$N = F_2 \times \cos\alpha$$
$$F_4 = F_2 \times \sin\alpha$$
$$F_4 = f = \mu_s \times N$$
$$F_2 \times \sin\alpha = \mu_s \times F_2 \times \cos\alpha$$
$$\mu_s = \tan\alpha = 0.308$$
$$\tan^{-1} 0.308 = \alpha$$
$$\alpha = 17.1^\circ$$

At 17° or less the flipper will produce a false lock that will allow the fly-section to hang up until a vibration or impact allows the fly-section to telescope downward. Since the measured angle is only 21 degrees on this Werner ladder, there is no factor of safety in the avoidance of a flipper falselock. With wear or surface damage to the plastic flipper, the critical angle for α could be reached and there would be a hard false lock on the flipper.

There are solutions to the problem of increasing the angle α. One solution is to simply increase the length of the flylock, but this design change makes the tip-lock problem more probable with the typical flylock design. With a relatively short fly-lock as shown in the Werner ladder on Figure 6 and Figure 7, the ladder will easily flipper lock. With a long fly-lock as is on the subject ladder, the ladder does not easily flipper lock.

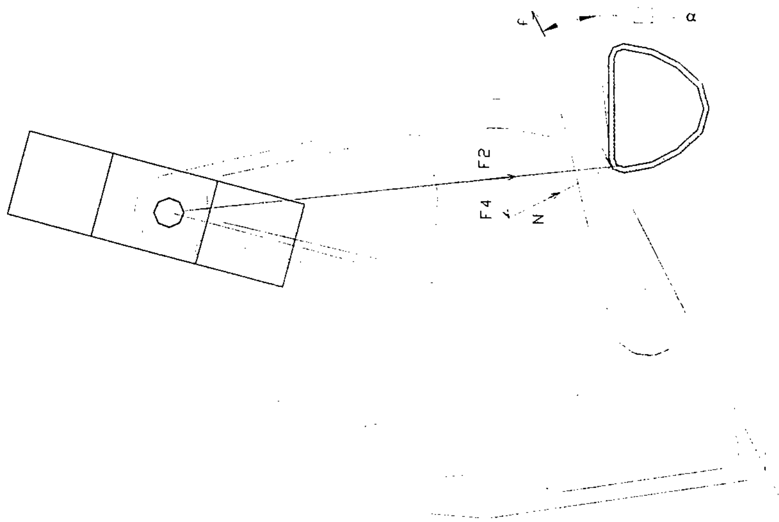


Figure 7. Free Body Diagram of Flipper Lock.

***Alternative Flipper Design*:**

The flipper can be totally eliminated with the design shown in the following photographs in Figures 8 and 9. This design was the first prototype to prove the concept. The totally redesigned flylock is discussed in another section that incorporates this push-off design to eliminate the flipper. Without the flipper there is no flipper false-lock.

As the fly-section is lowered, the push-off lever engages the rung and pushes the tip out past the rung. This action allows the fly-section to be lowered. To engage the flylock, the fly section is raised. As the tip clears the rung, the tip is free to swing in behind the rung to lock the flylock.

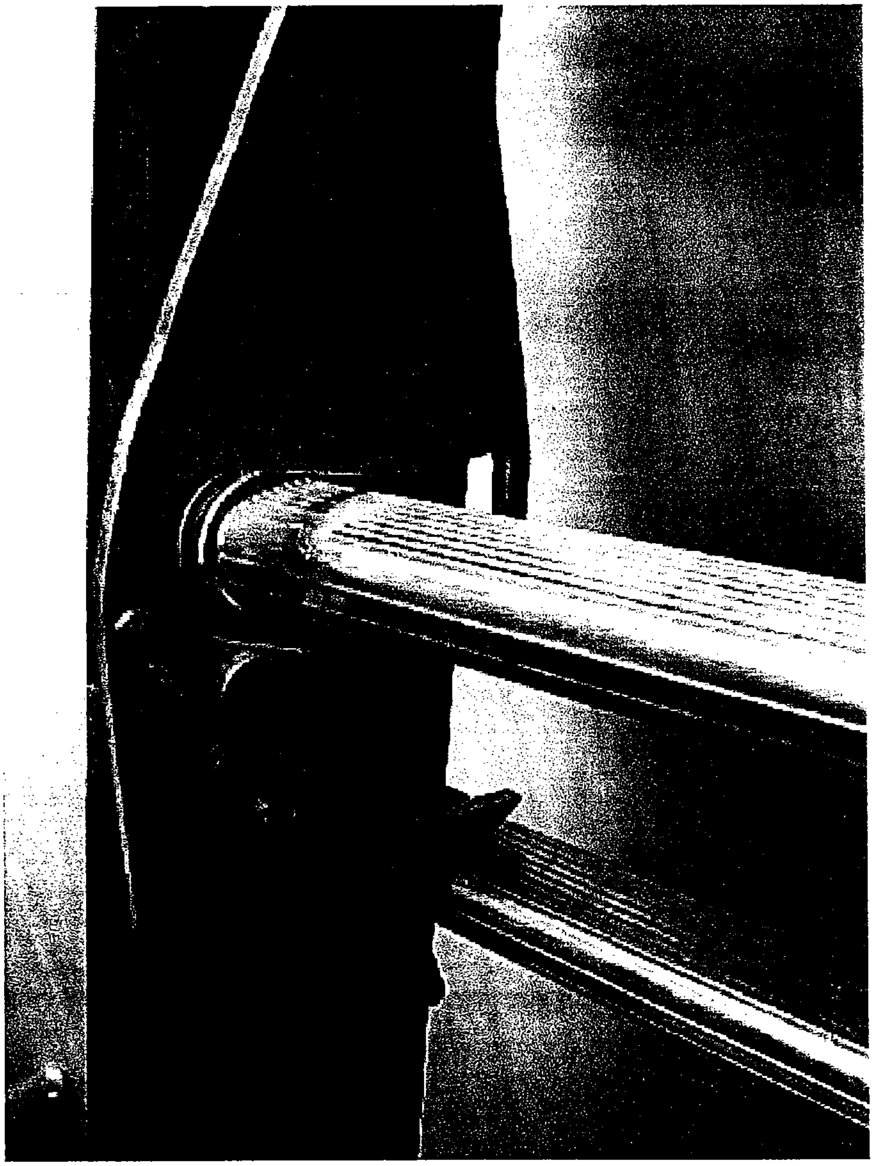


Figure 8. Push-Off Design to Eliminate the Flipper

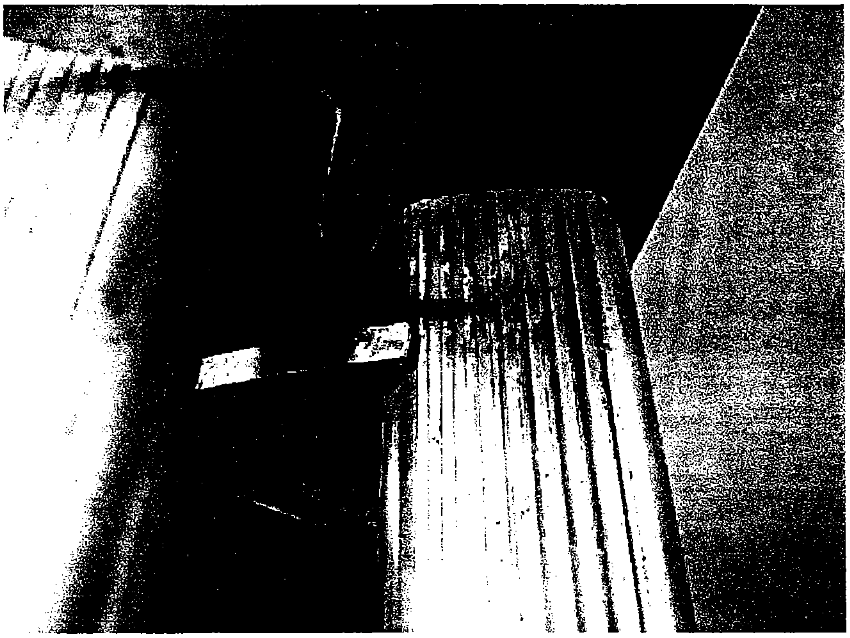


Figure 9. Push-Off Design Allows Tip to Clear

Tip-Lock Analysis

This push-off lever discussed previously solves only part of the problem. Flipper lock is eliminated, but the same tip lock problem exists. In Figure 10 is shown how the tip on this push-off design can still false-lock just as the production fly-locks false-lock.

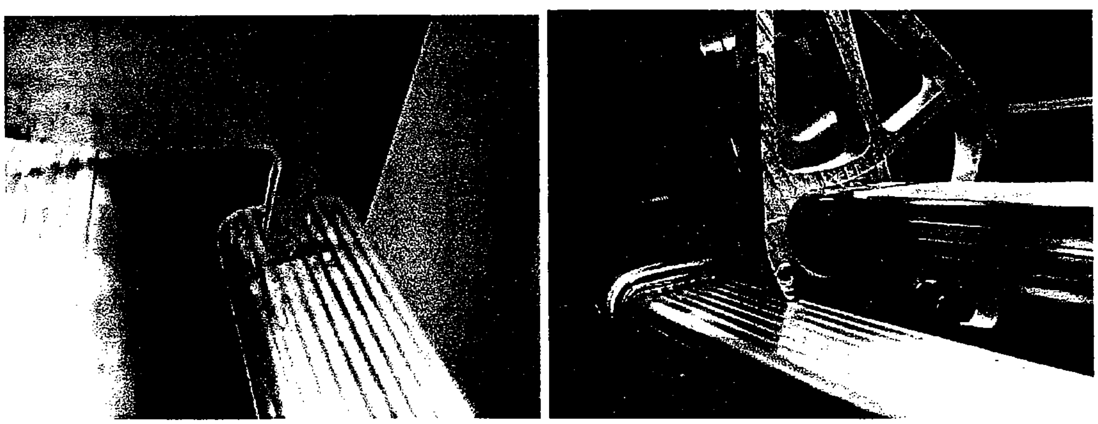


Figure 10. Tip Lock on Push-Off Lever Design and Typical Design.

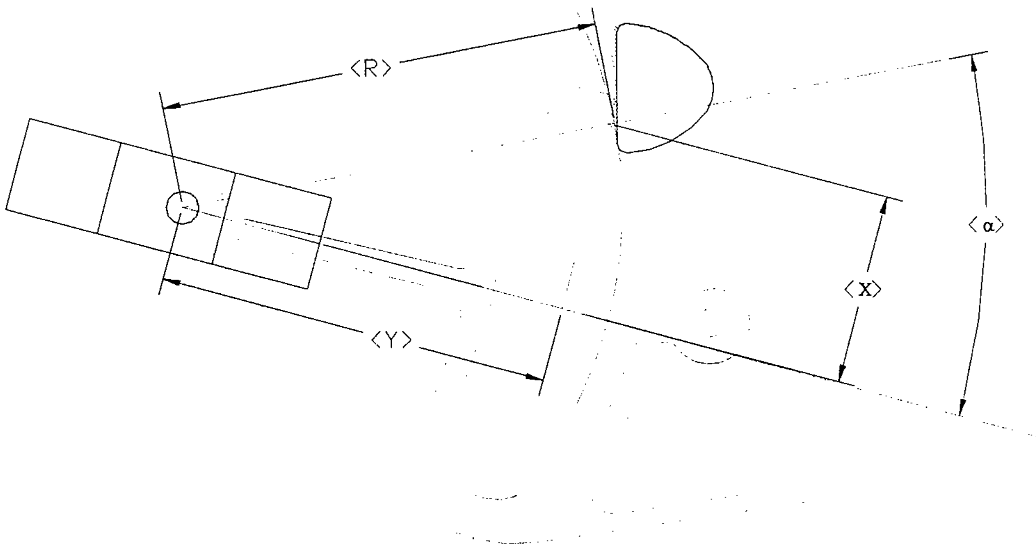


Figure 11. Free Body Diagram of Tip-Lock

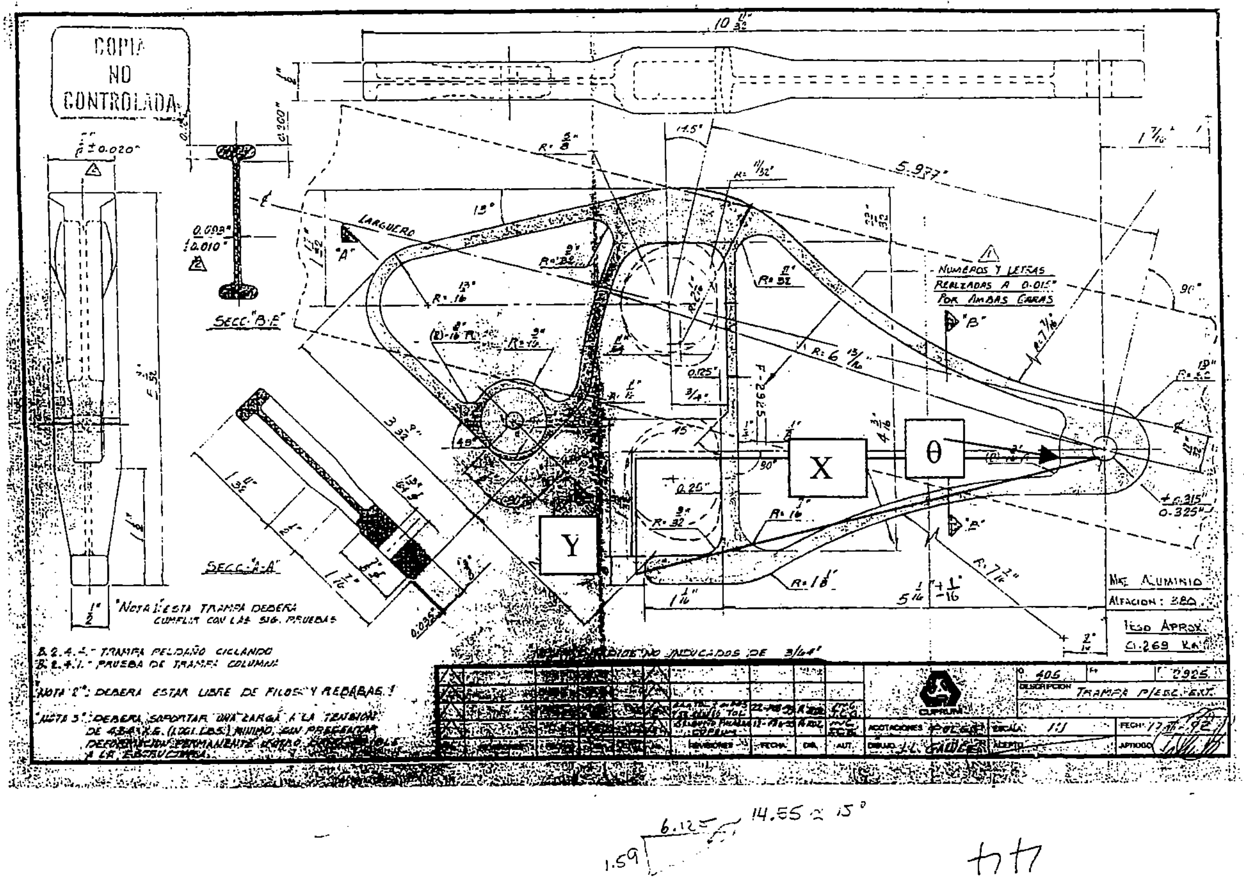


Figure 12. Actual Drawing of the Subject Ladder Flylock

From Figure 12, the red lines represent the triangle related to angle that the tip contacts the rung. The angle θ is:

$$Tan\theta = \frac{1.594}{6.125} = 0.26$$
$$\theta = 14.6 \approx 15^{\circ}$$

When the Cuprum ladder tip-locks, it swings into a position, along X, where the load is straight down on the rung at a 75°, which is a serious design error if tip-lock is to be prevented. A horizontal component tending to push the flylock into the locked position, along Y, would be desirable.

The vertical load is 225 pounds. Since the drawing in Figure 12 is rotated 90 degrees, the horizontal leg of the red triangle in Figure 12 is 225 pounds if tip lock occurs. The tops of the rungs are approximately horizontal. The value of the force along the tops of the rungs is of interest. If the friction force is higher than the horizontal force, the flylock will false-lock. See Figure 13. The Force

in the "X" direction (y direction on drawing) is trying to prevent tip-lock. As designed by the manufacture's, the tip-lock is a vertical force and has no component unlocking the false-lock. The blue line in Figure 13 represents a tip-lock with no horizontal force. If the location of the flylock is moved over to form a 15-degree angle, which is represented by the red lines in Figure 13, there is a horizontal unlocking force of 60.28 pounds.

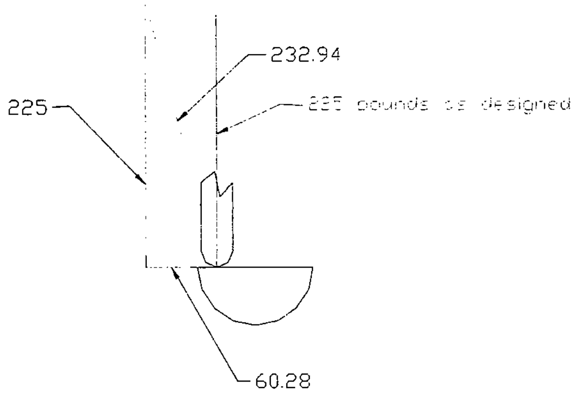


Figure 13. Analysis of Forces on Tip

$$Tan(15) = \frac{F_x}{225}$$
$$F_x = 60.28$$
$$F_f = \mu \times 225 = F_x = 60.28$$
$$\mu \le \frac{60.28}{225} = 0.268$$
$$\mu = 0.577$$
$$False - Lock$$

From the calculations, μ, the coefficient of friction, must be less than 0.268 to prevent a tip-lock. It becomes a two-fold solution. Change the angle when the false-lock occurs and reduce the

friction between the tip and the rung top. The ladder industry has failed to use old engineering tools, which science handed down from the Greeks, to properly design a fly lock.

The coefficient of friction was measured in one test by the author with aluminum on aluminum of μ=0.577. In other words, if the tip touches the surface of the ladder rung, false-lock will occur if the horizontal force does not overcome the frictional forces. It is obvious that the one way to eliminate tip-lock is to put a roller on the tip to lower the friction and to change the angle of the flylock so that there is a horizontal component.

The tip should also swing away faster from the rung surface with a shorter flylock.

***Alternative Tip Design*:**

Shown in Figure 13 and Figure 14 is a prototype of one solution to prevent tip-lock. Tip-lock is possible when the weight and the torsion spring cannot overcome friction of the tip resting on the top of the rung. With a roller on the end of the tip and the ridges removed under the roller, it becomes difficult to tip-lock the flylock.

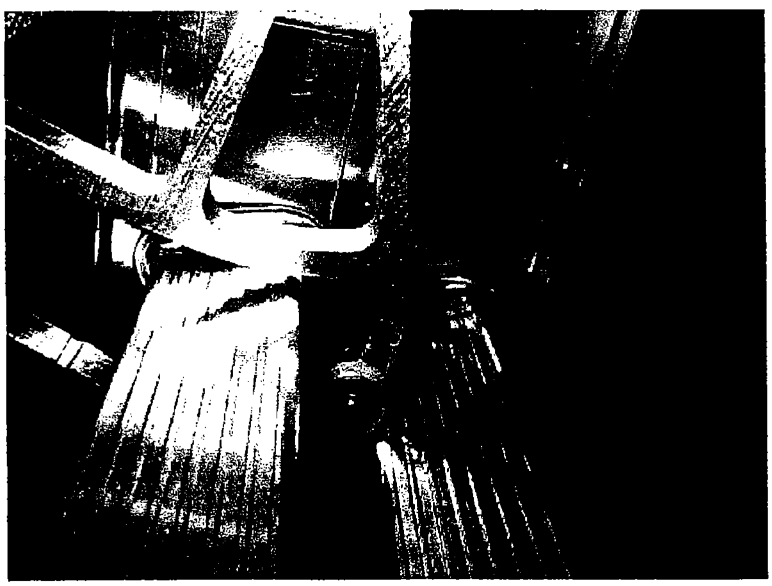


Figure 14. Prototype Roller on Tip

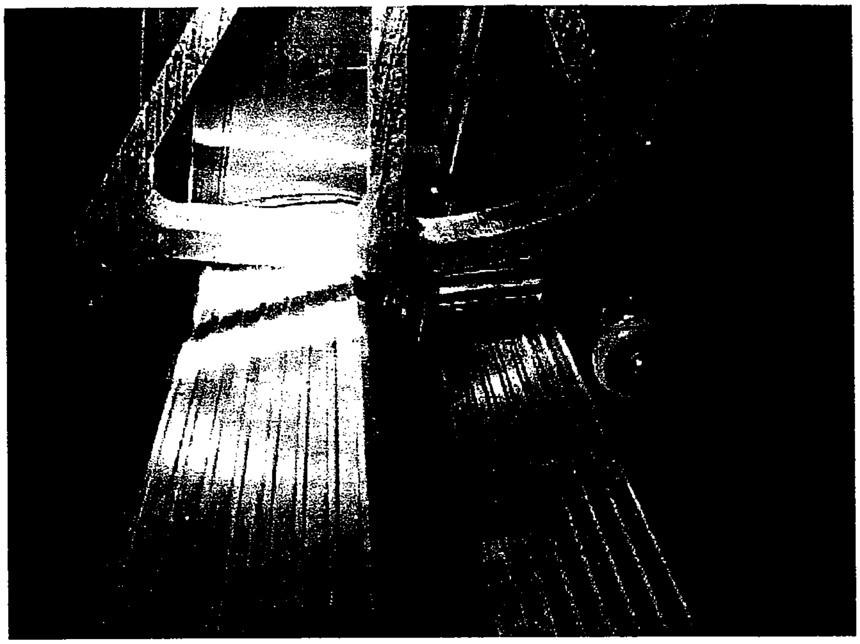


Figure 15. Prototype Roll on the Tip of the Flylock

This particular design shown in Figure 14 and 15 was improved in later versions to meet commercial applications.

Safeguards for Extension Ladders:

Shown in Figure 16 is a lock that backs up the defective fly-lock system. This Louisville ladder is a major safety improvement if warnings are effective in getting climbers to check and use the locks. The Louisville patent shows that it was invented in 1995, but it can be assumed that the design concept precedes the actual patent date.

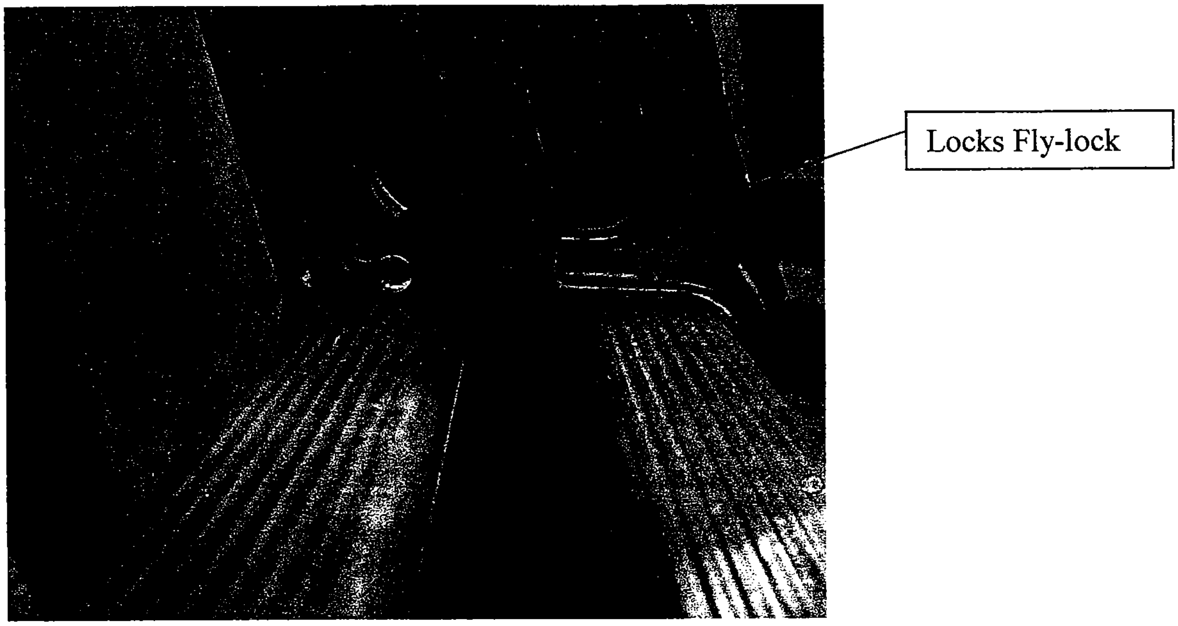


Figure 16. Louisville Ladder Safeguard

Patents shown next give other examples of safeguards to fix the defective design of the fly-locks used on the accident ladder. There is a plethora of safeguard ideas, and some of these are being sold. This proves a couple of things. First, the problem of false lock is so extensive that companies and individuals are inventing solutions. Second, false lock can be safeguarded if the ladder company engineers cannot fix the fly-lock problem. Safety Engineering Resources has eliminated flipper-lock and has reduced tip-lock significantly with our design.

Note the first patent showing round rungs. It would be difficult to tip-lock a round ladder rung. The rungs changed to flat rungs, but the fly-lock design stayed the same.

United States Patent [19]

Hawkins

[11] **4,299,306**

[45] **Nov. 10, 1981**

[54] **EXTENSION LADDER LOCK**

[75] Inventor: **Harvey G. Hawkins**, Salem, Ind.

[73] Assignee: **Emerson Electric Co.**, St. Louis, Mo.

[21] Appl. No.: **101,150**

[22] Filed: **Dec. 7, 1979**

[51] Int. Cl.[3] E06C 7/06

[52] U.S. Cl. 182/210

[58] Field of Search 182/210, 211, 209, 208, 182/207

[56] **References Cited**

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1,059,340	4/1913	Boyer	182/210
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134478	11/1919	United Kingdom	182/210
1053619	1/1967	United Kingdom	182/210

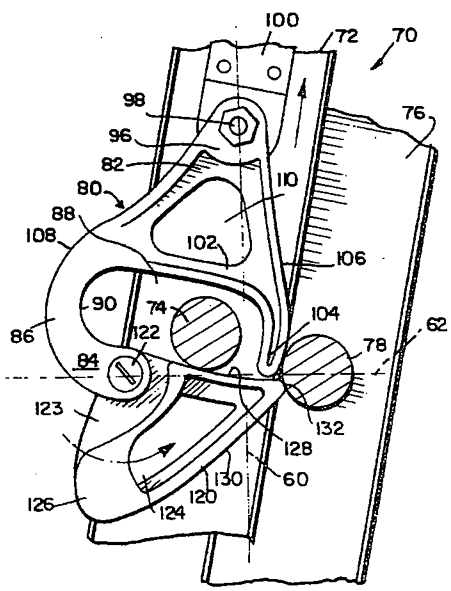
Primary Examiner—Reinaldo P. Machado

Attorney, Agent, or Firm—Polster, Polster and Lucchesi

[57] **ABSTRACT**

A lock for an extension ladder of the type having a movable frame section and a stationary frame section includes a first member forming a guideway which has an open end for receiving stations of the ladder and a second member forming an arm for guiding the lock past the stations of the ladder when the ladder is being extended or retracted. The first member has an elongated projection extending downwardly at the open end of the guideway for containing the stations within the guideway. A pivotal connection between the first member and the second member is located to a first side of a center line of the lock and the projection is located to a second side of the center line when the lock is freely hanging. When the open end of the guideway is closed by the second member, the tip of the projection, a cam surface of the second member, and the pivotal connection are generally in the same plane which forms an angle of 90° or less with the projection. The lock is swingably connected to the movable frame section, and the pivotal connection between the first member and the second member is located along a lower portion of the first member so that it lies generally above a horizontal plane which bisects a station of the stationary frame section and is coincidentally tangent to the tip of the projection.

13 Claims, 4 Drawing Figures



US005429207A

United States Patent [19]

Frank et al.

[11] Patent Number: 5,429,207

[45] Date of Patent: Jul. 4, 1995

[54] RUNG LOCK AND LATCH ASSEMBLY FOR AN EXTENSION LADDER

[75] Inventors: William H. Frank, Anchorage; Claude R. Wallick, Jr., Louisville, both of Ky.

[73] Assignee: Emerson Electric Co., St. Louis, Mo.

[21] Appl. No.: 197,745

[22] Filed: Feb. 17, 1994

[51] Int. Cl.⁶ E06C 7/06

[52] U.S. Cl. 182/209

[58] Field of Search 182/209–213

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3,565,211 2/1971 Leblanc 182/211
4,299,306 11/1981 Hawkins 182/210
5,117,943 6/1992 Schmitt et al. .

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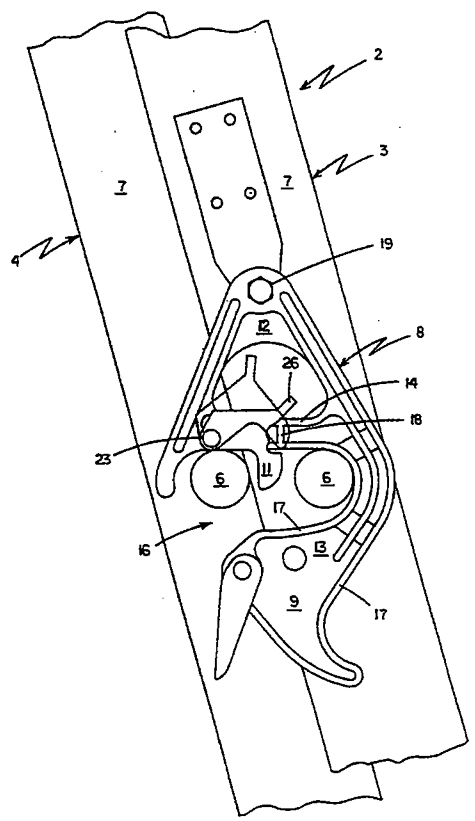
12498 of 1913 United Kingdom 182/212

Primary Examiner—Alvin C. Chin-Shue
Attorney, Agent, or Firm—Polster, Lieder, Woodruff & Lucchesi

[57] ABSTRACT

A rung lock frame and a mechanical latching structural assembly for selectively releasably locking and releasably and augmentally latching a pair of adjacently positioned rungs of relatively slidable ladder sections of an extension ladder, the rung lock frame and latching structure including guide rib and inclined ramp arrangement to permit ready movement of said latching structure into and out of augmental latching position on the rung lock frame.

10 Claims, 2 Drawing Sheets



United States Patent [19]
Forte

[11] **3,768,123**
[45] **Oct. 30, 1973**

[54] **SAFETY DEVICE FOR AN EXTENSION LADDER AND METHOD OF MOUNTING**

[76] Inventor: **Frank N. Forte,** 65 Dale Street, Boston, Mass.

[22] Filed: **Aug. 31, 1972**

[21] Appl. No.: **285,334**

[52] **U.S. Cl.** .... **24/73 CS,** 182/209
[51] **Int. Cl.** **A44b 21/00,** E06c 7/06
[58] **Field of Search** .... 182/207, 209, 230; 24/73 CS, 73 HH, 73 R, 81 R, 73 CC, 81 CC, 73 ES, 73 SG, 73 SS, 73 CE, 73 CF, 84 A, 84 C, 81 A, 81 SC, 81 SK, 81 CT

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2,742,679	4/1956	Young	24/73 CS X

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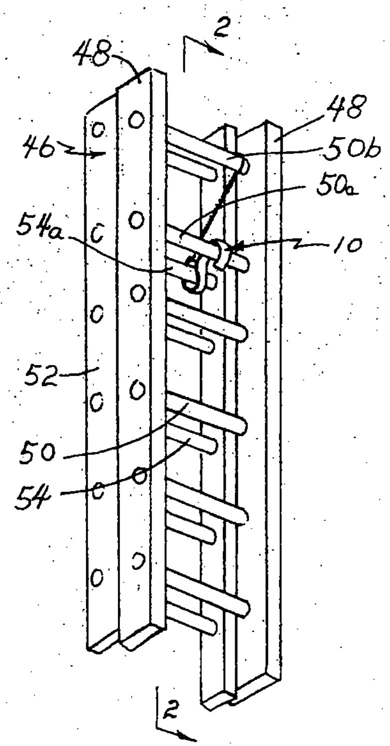
25,298	11/1919	Denmark	24/73 HH

Primary Examiner—Donald A. Griffin
Attorney—Harold E. Cole

[57] **ABSTRACT**

A safety device for an extension ladder has a lock member with three legs and two loop members connecting said legs, to one of which legs an elongate, resilient hook member is attached. The lock member is mounted on ladder rungs by placing one loop member directly below one ladder rung and rotating the lock member until it is above said rung, while the other loop member is now directly below a rung of another ladder, and raising said hook member to the next rung above either, and hooking it over the latter rung.

3 Claims, 5 Drawing Figures



US005117943A

United States Patent [19]

Schmitt et al.

[11] Patent Number: 5,117,943

[45] Date of Patent: Jun. 2, 1992

[54] RUNG LOCK ASSEMBLY FOR AN EXTENSION LADDER

[75] Inventors: Thomas J. Schmitt; Claude R. Wallick, Jr., both of Jefferson County, Ky.

[73] Assignee: Emerson Electric Co., St. Louis, Mo.

[21] Appl. No.: 765,568

[22] Filed: Sep. 25, 1991

[51] Int. Cl.[5] E06C 7/06

[52] U.S. Cl. 182/213

[58] Field of Search 182/209, 210, 211, 212, 182/213

[56] References Cited

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802,017	10/1905	Newton	182/213
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2,310,441	2/1943	Klum	182/213
4,299,306	11/1981	Hawkins	182/210

FOREIGN PATENT DOCUMENTS

748515	5/1956	United Kingdom	182/213

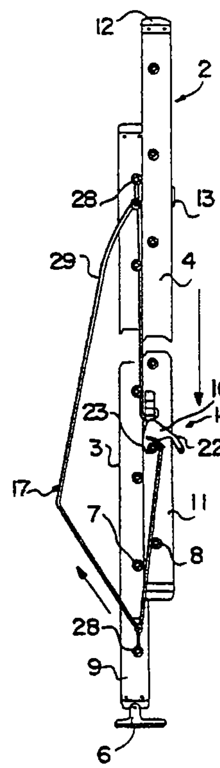
Primary Examiner—Reinaldo P. Machado

Attorney, Agent, or Firm—Polster, Lieder Woodruff & Lucchesi

[57] ABSTRACT

A rung lock assembly for selectively and releasably locking a pair of adjacent rungs of relatively slidable fly ladder and base ladder sections of an extensible ladder including a rung lock frame pivotally mounted within the fly ladder section to be normally urged into engagement with adjacent rungs of the ladder sections and a pulley and cable system cooperative with the rung lock frame to release and move the same away from such engagement for relative slidable movement of the ladder sections.

14 Claims, 3 Drawing Sheets



United States Patent [19]
Eisenberg

[11] **Patent Number:** **5,035,299**
[45] **Date of Patent:** **Jul. 30, 1991**

[54] **METHOD AND DEVICE FOR EXTENSION LADDER SAFETY**

[76] Inventor: **Martin A. Eisenberg**, 3577 NW. 16th Blvd., Gainesville, Fla. 32605

[21] Appl. No.: **561,149**

[22] Filed: **Aug. 1, 1990**

[51] Int. Cl.[5] E06C 7/06
[52] U.S. Cl. 182/212
[58] Field of Search 182/207, 209, 212

[56] References Cited

U.S. PATENT DOCUMENTS

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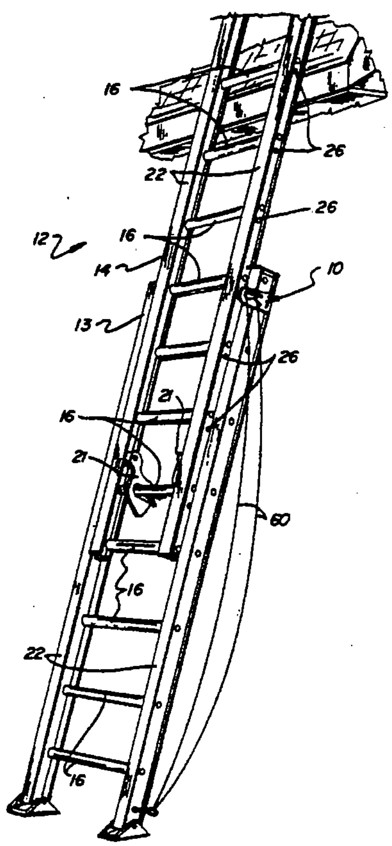
2610265	9/1977	Fed. Rep. of Germany .
3611762	10/1986	Fed. Rep. of Germany .

Primary Examiner—Reinaldo P. Machado
Attorney, Agent, or Firm—Linda Flewellen Gould

[57] **ABSTRACT**

The safety of a user of an extension ladder may be increased by a method of testing whether a fly section has been properly extended and locked into position, which method also impedes inadvertent descent of the fly section. The method of increasing safety of using an extension ladder involves the use of a locking device, comprising an insertion pin designed to be inserted into an insertion hole extending from side to side of a rail on one section of the ladder. The insertion pin is attached to the side of a corresponding rail on the other section of the ladder. The attachment of the insertion pin and the location of the insertion hole are designed so that the insertion pin may be inserted into the insertion hole only when the fly section is properly positioned with respect to the base section, to ensure that rung locks are engaged to hold the fly section in place.

13 Claims, 2 Drawing Sheets



United States Patent [19] [11] 4,364,451

Wright [45] Dec. 21, 1982

[54] **LADDER LOCK**

[75] Inventor: Allen C. Wright, Moraga, Calif.

[73] Assignee: Utility Products, Inc., Oakland, Calif.

[21] Appl. No.: 861,220

[22] Filed: Dec. 16, 1977

[51] Int. Cl.[3] E06C 7/06; E06C 1/08
[52] U.S. Cl. 182/213
[58] Field of Search 182/209, 210, 211, 212, 182/213

[56] References Cited

U.S. PATENT DOCUMENTS

856,875	6/1907	Hughes et al.	182/210
1,170,395	2/1916	Beatty	182/210
2,310,441	2/1943	Klum	182/213

FOREIGN PATENT DOCUMENTS

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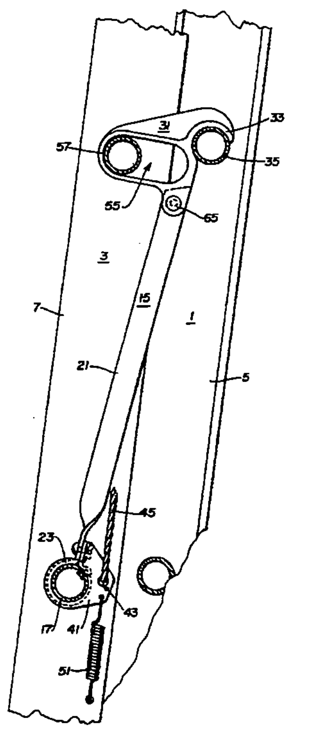
Primary Examiner—Reinaldo P. Machado
Attorney, Agent, or Firm—Manfred M. Warren; Robert B. Chickering; Glen R. Grunewald

[57] ABSTRACT

A locking mechanism for a ladder of the extension type having sections slidable over each other where such locking mechanism is affixed to one section and hooks over a rung of the other section to secure the two sections at the desired height, and where such locking mechanism is withdrawable from the plane of the second section during raising or lowering of this section such that it does not bounce and bump against the rungs of the second section during raising or lowering.

5 Claims, 3 Drawing Figures



United States Patent [19]

Shaw

[11] **Patent Number:** **4,467,891**

[45] **Date of Patent:** **Aug. 28, 1984**

[54] **LOCK MECHANISM FOR EXTENSION LADDER**

[75] Inventor: **Jonathan L. Shaw,** Clinton Township, Hunterdon County, N.J.

[73] Assignee: **AT&T Technologies, Inc.,** New York, N.Y.

[21] Appl. No.: **508,400**

[22] Filed: **Jun. 27, 1983**

[51] **Int. Cl.**³ **E06C 7/06**

[52] **U.S. Cl.** **182/210**

[58] **Field of Search** 182/209, 210, 211, 212, 182/213, 66, 67

[56] **References Cited**

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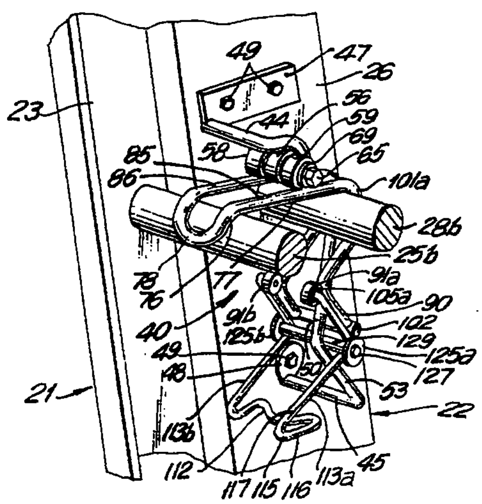
679,385	7/1901	Klemme et al.	182/210
4,299,306	11/1981	Hawkins	182/210

Primary Examiner—Reinaldo P. Machado
Attorney, Agent, or Firm—R. F. Kip, Jr.

[57] **ABSTRACT**

There is disclosed a releasable lock mechanism for an extension ladder comprising a bell crank lever attachable to a fly rail of the ladder through a first pivot, and having first and second joined arm segments extending generally forward and downward, respectively, from their juncture. The first arm segment has at its front a head movable by pivoting of the lever between first and second positions at which the head will and will not, respectively, engage base rungs of the ladder. A tongue with a tip is attached to a lower part of the lever's second arm segment through a second pivot. Attachable to the rail is a frame operable during downsliding of the ladder's fly section to guide translatory movement of the tongue so that strikings of its tip by base rungs of the ladder are effective to pivot the lever to permit its head to pass by such rungs. When the lever head engages the top of a base rung to lock the fly section from downsliding, the tongue is held against flapping about the second pivot.

27 Claims, 10 Drawing Figures



United States Patent [19]

Inglese

[11] **Patent Number:** **4,605,100**

[45] **Date of Patent:** **Aug. 12, 1986**

[54] **LADDER EXTENSION LOCK**

[75] Inventor: Giulio S. Inglese, Granada Hills, Calif.

[73] Assignee: Uniprode, Granada Hills, Calif.

[21] Appl. No.: 770,971

[22] Filed: Aug. 30, 1985

[51] Int. Cl.⁴ E06C 7/06

[52] U.S. Cl. 182/213; 182/211

[58] Field of Search 182/209–213

[56] **References Cited**

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750,504	1/1904	Tiefel	182/213
1,964,067	6/1934	Leach	182/213
2,210,803	8/1940	Dunn	182/213
2,310,441	2/1943	Klum	182/213
4,299,306	11/1981	Hawkins	182/210
4,364,451	12/1982	Wright	182/213

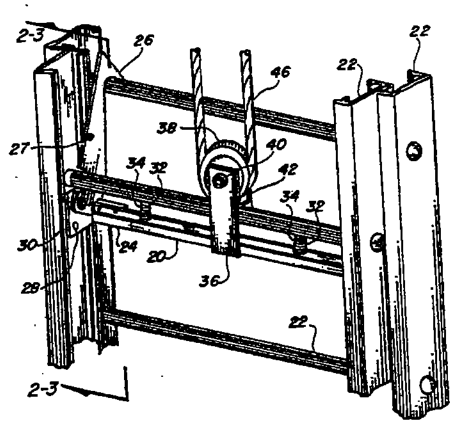
Primary Examiner—Reinaldo P. Machado

Attorney, Agent, or Firm—Albert O. Cota

[57] **ABSTRACT**

A ladder extension lock that serves as a back-up unit for an existing ladder lock system. The inventive lock releasably locks in place a section of a multiple section extension ladder. The lock is comprised of a control bar (20) planar with a rung on the fly section, having pivot pins (24) on each end. A pair of hooks (26) are attached to the pivot pins (24) and mounting blocks (28) are fastened to the side rails of the ladder and also the hooks (26). A pair of springs (37) are disposed between the bar (20) and the rung, urging the bar away from the rung. A pully (38), attached to a yoke (36), allows a halyard (46) to be engaged within a groove in the pulley (38). When an operator applies force upon the halyard (46), the bar (20) is forced upward rotating the hooks (26) to clear the rungs of the ladder while hoisting, and when pressure is quickly released, the hooks (26) rotate to their locking position and mate with the rung, creating a fail-safe mechanical lock between the rung and the side rails.

6 Claims, 9 Drawing Figures



Finally, to further illustrate a safeguard, the Ladder Lash is shown in the Figure 17.

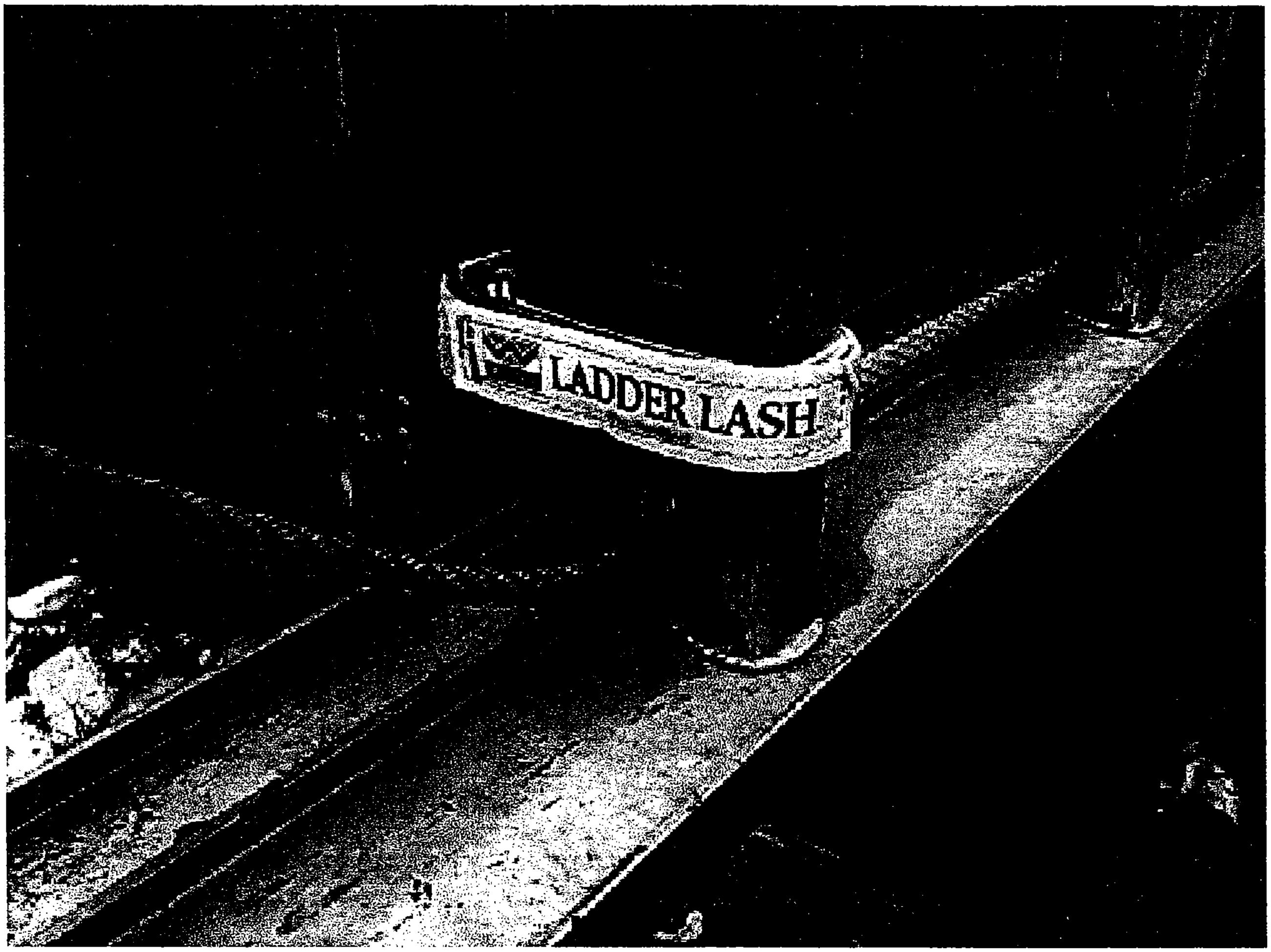


Figure 17. Ladder Lash to Safeguard Extension Ladders

This simple device uses a Velcro strap. Velcro was invented in the 1950's so state of the art is not an issue.

Safety Design, the Peer Reviewed Procedure:

Priority in Product Design

The American Society of Mechanical Engineers (ASME) code of ethics states as its first fundamental tenant that "**Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties**", (see appendix). The American Society of Agricultural Engineers (ASAE) includes this code of ethics within its constitution. It is clear that safety should be the first and foremost design parameter for any engineering project. The following **five**

safety priorities are viewed as the **Hierarchy of Safety.** Whenever possible, engineering and design work should use the highest priority according to this safety protocol. The first two priorities relate directly to a change in the physical design to eliminate or guard against any hazard (best solutions). The last three priorities (least desirable) deal with modifying people's behavior.

Often in the courts there is the impression that there is no priority system for safety design. Warnings and behavior modification often are presented as solutions. This does not follow the procedure laid out by the National Safety Council nor Safety experts that write textbooks for advanced training. If warnings and behavior modification would work, all the automobile manufacturers need is a good safety sticker on the dash warning that the driver should not run into anyone. Seat belts, airbags and crush zones would not be needed.

There is a preferred first solution to protect people from injury. There is a second choice that is not as good as the first, but will protect the ones who inadvertently come in harm's way. Then, there is a third choice that is even less effective. The fourth and fifth steps downward in the design priorities are the last steps of desperation in minimizing hazards. If the product designer selects the third or fourth item in the "Design Priority" when he or she could have used the better second choice or the best first choice, the product may still be unreasonably dangerous. To get the greatest effectiveness in product safety, the designer must start at the top of the design priority list and work downward.

According to the Accident Prevention Manual by the National Safety Council and other peer-reviewed publications the following priority list must be followed with any product design:[1]

Priority One:

The top priority in safe product design is to eliminate the hazard through design. The solution of designing out the hazard works for all users, the genius and the idiot. There is no need for the lower priorities if the hazard is eliminated through **design.**

Priority Two:

The second best solution to the problem of potentially dangerous products is to neutralize the hazard with fixed guards, automatic-stop devices, or other protective safety devices. In Priority Two, the designer cannot eliminate the hazard by designing the hazard away. The hazard remains, but something is done to reduce this hazard that doesn't require behavior modification of the product user. For example, the danger in a power saw cannot be designed away, but the saw blade can be covered with a guard.

Priority Three:

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[1] Krieger and Montgomery, Accident Prevention Manual, Engineering & Technology, 11th Edition, National Safety Council, Itasca, IL P 4, 5.

The third alternative is to provide warnings. If the hazard cannot be designed away or guarded away, warnings are the next option. Written warnings and pictograph warnings are the two warnings commonly found on products today.

Priority Four:

Lower yet in the pecking order of hazard removal is the development and implementation of operation procedures and employee training programs. When it cannot be designed away, guarded away, or warned away, behavior modification is another alternative. Many married people have had a lifetime trying the fourth alternative without success, and without diligence it doesn't work well in training employees, either.

Priority Five:

When all else fails, product users are given protective equipment and clothing, which provide some protection.

The best choice is to eliminate the hazard. For example, in the subject extension ladder, the Ryan Engineering fly-lock design will prevent the normal false-lock from the fly-lock. In other words, elimination of the hazard is possible and should be done. ***The second best choice*** is to safeguard the hazard by using a safety lock such as patent 5,429,207 that is assigned to Emerson Electric and is in use on some new Louisville extension ladders. ***The third ineffective choice*** is to warn. There is no warning that would have prevented the accident. This Plaintiff is on the roof. The ladder by necessity is moved. You cannot see the fly-locks. Mr. Stevens had to come down. It can take up to 4 minutes to read standard ladder warnings, which few users will do. Since it is possible to design out the hazard and to safeguard the hazard, warnings cannot be substituted for the higher design priorities. The same argument holds for ***behavior modification*** and ***personal protective devices***. The only solution to extension ladder false-lock is to design a fly-lock that works.

Figure 18: A Railroad Overpass

A good illustration of the priority concept in design would be an example of how to protect cars from trains. This illustration helps juries see why so many textbooks on safety and the National Safety Council follow this design procedure.

The best and most effective solution is to ***eliminate the hazard*** by installing highway overpasses over the railroad. With this design priority, the hazard has been removed through design with an overpass. It is virtually impossible to have a train and car wreck with an overpass.

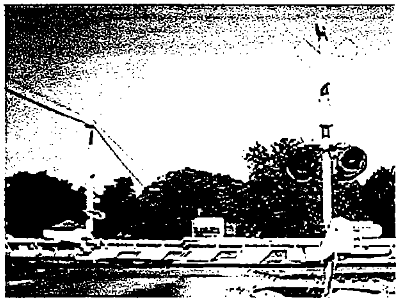

Figure 19: A Guarded Railroad Crossing

The next best thing is to ***provide a guard*** by having a railroad crossing guard that comes down with red lights flashing when a train approaches. This is the second design priority in preventing car and train accidents. This guard will prevent most accidents. Occasionally, someone will run through the gate or the gate may fail.

Figure 20: A Railroad Crossing With Warning Sign

The next step downward in the design priority list is ***to warn*** by installing a typical railroad warning sign. This approach to safety is cheaper and obviously less effective than a gate or guard that blocks the highway. People might not see the warning sign or they could ignore the sign.

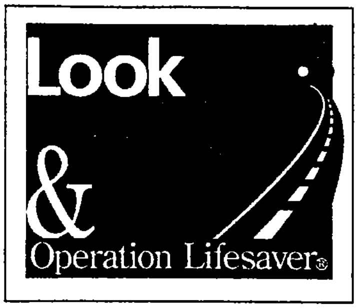

Figure 21: A Driver's Education Poster on Railroad Crossings

The next step downward in the National Safety Council's priority list is to ***provide training*** by having driver training classes. Behavior modification is a lofty goal that does not work very well for all people. Train kids in high school to stop, look and listen, but it is foreseeable that due to inattention, slips, or gross error, people will get killed at unguarded and unmarked railroad crossings.

Figure 22: When All Else Fails, Side Impact Air Bags

The last and lowest design priority is to ***provide personal protection devices*** like side impact air bags. Side impact air bags would be nice, but who wants to test them when hit broadside by a train?

Ryan Engineering's and Safety Engineering Resources' decisions on whether we represent defendants or plaintiffs hinges on how well the product designer followed the National Safety Council's safety design priority list. The National Safety Council's design priority list is a one-way design street that must be followed. Juries will reach better decisions if product liability lawyers and expert witnesses help them understand this truth.

Supporting Publications

Literature Review

Standards

(The ANSI 14 standard does not address the issue of false lock. Tests are conducted that prove the durability of the defective flylock, but no tests are conducted to test for false-lock involving the flipper lock or tip lock. A letter from Mr. Harold W. Stillman, a retired member of the ANSI committee, agrees that false-lock is a problem. Mr. Stillman, who has served on the ANSI ladder

committee for over 30 years, addressed a letter to the author stating: "False Locks. This is a problem, and is worthy of any input you are willing to suggest. To make changes in lock design you should expose as many people as possible to the hazard." He also notes that warning labels will be only partially effective in reducing accidents.

The ANSI A14.2 test on the fly-locks does not test for false lock because the ladder is moved up and down where false-lock cannot occur. False-lock occurs when the fly-lock is stopped near the rung. The ladder is moved 6-inches upward to allow the rung lock to engage the rung. It is moved 6 inches downward to disengage the fly-lock. Next it is moved 12-inches upward and then moved 12 inches downward to the starting position. The fly-locks can be manually lubricated before and during the test. The ladder is set up at 75.5° angle and stroke speed is 6 to 12 inches per second. The test is run for 6,000 cycles. "Any malfunction of the rung lock (fly-lock in this discussion) or fracture of its components, including springs, shall be considered a failure."

In other words, there are no ANSI tests for false-lock, only endurance tests for the fly-lock mechanism. Likewise, there is no false-lock test by UL. UL, according to various publications, copied ANSI standards in general.

Eliminate False Lock Makes the Ladder Safe:

If there were no false locking of extension ladders, the ladder would always telescope downward until the flylocks were properly locked. The author has had a number of cases involving false locking. The problem has been that the false lock allowed the user the opportunity to climb a ladder that was false locked until vibrations or movement caused the ladder to telescope. This usually happens with the climber part way up or down the ladder. Moving a ladder from the top is often a requirement. Users can unlock a properly locked ladder and then attempt to reengage the flylocks. If the ladder appears to lock by feeling it stop, the user concludes that the flylocks are in place. It is impossible to see the flylocks from the top.

Warnings:

The warnings on one side of the ladder consisted of "Secure the Locks" with an arrow pointing to the middle part of the ladder. The warnings on the other side are in small print, and take from 3 to 4

minutes to read. This label states, "Securely engage ladder locks." The newer warning labels for extension ladders are pictographs that show the user in pictorial form on what to check to see if the locks are engaged. There was no information about the nature of the locks or how to secure the locks on the accident ladder. There are no warnings about the consequence of false locking of the fly-locks, these warnings are inadequate as they stand.

To depend on a warning placed on the side of the ladder that is buried in 4 minutes of reading is not an acceptable solution. This would be like putting a safety sticker on the dashboard of an automobile saying, "Warning, do not hit anyone while driving", and this warning sticker would eliminate the need for air-bags and seat-belts. Warnings cannot be used to solve this safety problem as is referenced in the National Safety Council's publication, which is the standard of care in the industry. The hazard can be designed out, which is priority number one, and the hazard can be safeguarded, which is priority number two. Warnings are down on the list to number three.

Opinions:

The following opinions are based on a reasonable degree of engineering certainty unless otherwise stated. The extension ladder fly-locks are a functional part of the ladder. These locks must work properly without depending on the user to spot the defective false lock that occurs because of an unreasonably dangerous design. The manufacturer should allow for an anticipated user missing the unexpected false locking of the ladder particularly when users are not aware that such things happen regularly. The manufacturer cannot rely on the ANSI or OSHA standards that do not test for false-lock. Since the hazard can be designed out or provided with a safeguarded as Louisville Ladder does now, the manufacturer should follow the National Safety Council's procedure for safety design, which is the standard of the product design industry.

1. Using deposition testimony, screen damage and witness marks on the ladder, the extension ladder was "***tip locked***" on the 9th rung from the bottom with the right fly-lock. This caused the left fly-lock to be positioned above the rung about 1 inch. The impact of the left fly-lock on the left side of the rung is very evident. When the tip lock slipped off, the left fly-lock impacted the rung and the fly-lock failed. Due to the rope and other sliding friction that slowed the falling of the fly section, the right fly-lock was able to rotate in enough to impact the 7th rung leaving telltale witness marks. Considering the amount of fall and the window screen witness marks, it is my opinion that Figure 4 represents with a reasonable degree of engineering certainty the ladder set up before the fall.
2. It is my opinion that the ladder fell two rungs with the right fly-lock tip locked on the 9th rung and then falling to impact the 7th rung.
3. It is my opinion that the left fly-lock was in place when the right fly-lock was tip locked. When the tip-lock on the right fly-lock slipped off the 9th rung, the impact of the drop broke the left fly-lock. The ladder telescoped downward where the right fly-lock impacted the 7th rung.
4. There are witness marks up and down the left rungs indicating that the left rung was intact and working. Other experts and the author have raised and lowered the ladder with only the right fly-lock in place. It is my opinion that the more numerous witness-marks come from testing the ladder with only the right fly-lock remaining in place.
5. The accident reconstruction follows the plaintiff's sworn testimony except for the fact that the extension ladder was extended when moved from the great room roof-line to the higher roof-line. The plaintiff's boys have recently stated off the record that they did extend the ladder once they had moved the ladder over to the second position. When the plaintiff's boys extended the ladder with

the plaintiff on the roof, the ladder tip-locked on the 9th rung. It is my opinion that the extension ladder was extended when moving to a higher roof-line, and when looking downward from above, the plaintiff was physically unable to determine whether the ladder was securely locked. (See photo on Page 6.)

6. It is my opinion that the ladder was properly locked when the plaintiff climbed the ladder to get onto the roof. False lock creates a difference in the level of the rungs. It can be seen from below if the user knows what they are looking for, but not from above. Tip-lock can hold significant weight, but it is easily dislodged allowing the ladder to telescope. There is a reasonable degree of engineering certainty that the plaintiff could not have climbed the entire ladder to get onto the lower roof with the ladder tip-locked.
7. If false locking is designed out, the hazard is removed. Either the fly-lock is engaged or it is not. If the lock is engaged the climber is safe. If the lock is not engaged, the ladder immediately telescopes before the climber has a chance to get onto the ladder. It is my opinion that false locking of the fly-locks, namely a tip-lock, makes the Cuprum Model 405-28, type II extension ladder unreasonably dangerous.
8. It is my opinion that the subject ladder did not "flipper lock" because the user climbed part way down before the ladder telescoped. A flipper lock is very unstable and would be expected to telescope shortly after the plaintiff stepped on to the ladder. Since long fly-locks tend not to flipper lock easily and the subject ladder only flipper locked once with many tests, it is the opinion of the author that the accident did not involve a flipper lock.
9. Mr. Dennis L. McGarry, PhD, PE, and Larry G Goodwind, PE, apparently defense employed experts from S.E.A., agree that the ladder was false locked. In Dr. McGarry's report he states, "The primary cause of the accident was improper engagement of the locks in violation of the Safety Instructions written on the ladder." Another supporting statement from McGarry's report, "At least one and probably both of the locks were not securely engaged at the time of the accident." The conclusion is that defendant's expert and plaintiff expert agree that the ladder false locked, and that the false lock caused the accident.
10. It is my opinion that the National Safety Council's safety design priority list, which is the standard of care for the industry, should be followed to make a product safe. Since the hazard of false lock can be removed by redesigning the fly-locks, the highest and most effective solution is to design out the hazard of false lock, which should be done by the manufacturer. The next lower solution is to safeguard the hazard with a backup lock to hold the base and fly sections together after being adjusted to the proper height, which should be done by the manufacturer. The defendant now uses a

safeguard on their extension ladders. The next lower and known ineffective way is to warn, which again is the responsibility of the manufacturer, and this was not adequately done.

11. It is my opinion that the manufacturer could have prevented this accident through design. If warning stickers work, then air-bags, seat belts and crush zones are not needed because an inexpensive sticker on the dashboard of the car warning the driver to not hit anything would be adequate, and it is not. It is my opinion that the manufacturer is responsible to make a reasonably safe product, which allows some leeway for the product user.
12. It is my opinion that the left flylock was engaged, but it was approximately 1 inch up above the rung due to the right flylock resting on the tip. The right flylock was tip-locked or false locked. When the right flylock slipped off the rung, the left flylock took the impact and broke. These facts are stated in Opinion 1. According to the author's elementary metallurgical analysis, the aluminum flylock part from the left flylock shows signs of a crack. The pre-crack appears similar to fatigue striations under a 50 X magnification. The shiny area indicates a crack existed before the catastrophic failure. The drop of approximately one-inch increased the stresses on the left flylock with existing cracks and the flylock broke. There is a reasonable degree of engineering certain that the left flylock was defectively manufactured. Had the left flylock remained in tact, and the climber had both feet and at least one hand on the rail, the accident would not have occurred.
13. It is my opinion that the impact of a one-inch drop on the left flylock would produce forces larger than 225 pounds. The impact on the throat of the left flylock would induce bending stresses in the strong plane of the flylock, and depending if there were any side motion of flylock before impact, bending stresses could be introduced in the weak direction of the flylock when it fell. The author measured 0.658 side slop at the tip of the right flylock and noted side slop in the remaining left flylock. The combined stresses that result from the impact force, the compression and bending in two planes increased the stresses on the left flylock significantly.
14. It is my opinion that if a ladder false-locks, it is unreasonably dangerous and defectively designed. Since the author and defense experts agree that the Cuprum 405-28 aluminum extension ladder false-locked, the subject ladder is unreasonably dangerous and defectively designed. The ladder that false-locks will telescope downward when weight and motion of the climber are added to the ladder. A ladder that does not false-lock will telescope downward before a climber can get onto the ladder.
15. It is my opinion that the manufacturer failed to properly warn of false locking. The one warning that mentions to "securely engage ladder locks" is buried in a lengthy warning in very small letters. The other warning is placed on the decal that shows how to set up the ladder at the proper

angle, which is totally unrelated. This warning says to "secure locks", without explaining what the locks are or showing how to securely engage the locks. There is no instruction on showing how to determine if the locks are engaged. Compare the instructions on this ladder with a typical pictogram warning on many ladders.

16. It is my opinion that the manufacturer failed to warn of the consequences of improper ladder set-up related to fly-locks. A separate yellow warning label states "Failure to read and follow instructions on this ladder may result in injury or death." This is general, vague, and does not convey the danger of a false-lock. It takes 3 to 4 minutes to read the small print label on the side of the ladder that has trivial instructions and common sense instructions mixed up with important instructions.
17. It is my opinion that false-lock can be eliminated with design. The author has eliminated flipper lock and has developed the method to eliminate tip-lock. If the manufacturer's engineers are unable to design out the hazard, these engineers could have provided a safeguard. There are many patents and products on the market to safeguard against false-lock. Louisville Ladder has a safeguard that would have prevented this accident. The patent was filed February 17, 1994 and was assigned to Emerson Electric before this ladder was manufactured. (See Page 27, Figure 16.) Even the simple "Ladder Lash" could have been used. (See Figure 17, Page 36.)
18. It is my opinion that the Cuprum 405-28 aluminum extension ladder is defectively designed and unreasonably dangerous, and the design was responsible for the injury to the plaintiff.

3/11/04